



Oxford Cambridge and RSA

# AS Level Computer Science

## H046/02 Algorithms and problem solving

**Friday 8 June 2018 – Morning**  
**Time allowed: 1 hour 15 minutes**



**Do not use:**  
• a calculator



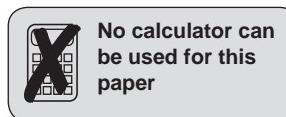
First name					
Last name					
Centre number	<input type="text"/>				
Candidate number	<input type="text"/>				

**INSTRUCTIONS**

- Use black ink.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.

**INFORMATION**

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [ ].
- Quality of extended responses will be assessed in questions marked with an asterisk (\*).
- This document consists of **16** pages.



No calculator can  
be used for this  
paper

2

- 1 A user enters whole numbers into a computer program. Each number entered is placed onto a stack. The stack is created using an array with a maximum of 20 elements.

Part of the array, numStack, is shown when one number has been input.

top	1
-----	---

index	stackItem
9	
8	
7	
6	
5	
4	
3	
2	
1	
0	20

The pointer, top, points to the next free space in the stack.

- (a) Complete the diagram below to show the state of numStack after the user inputs the following numbers in the order given:

22      13      2      59      1000

top	
-----	--

index	stackItem
9	
8	
7	
6	
5	
4	
3	
2	
1	
0	20

[2]

3

- (b) A function, addItem, takes a number as a parameter and adds the number to the stack. The function returns true if this was successful, and false if the stack is already full.

- (i) Give **one** reason why a function is used instead of a procedure in this scenario.

.....  
.....

[1]

- (ii) The parameter can be passed by value or by reference.

Describe what is meant by passing a parameter by value and by reference.

By value .....

.....  
.....  
.....

By reference .....

.....  
.....  
.....

[4]

- (iii) The function addItem is written but is incomplete.

Complete the function, addItem.

```
function addItem (number)
    if top == ..... then
        return false
    else
        numStack[.....] = .....
        top = ..... + 1
        .....
    endif
endfunction
```

[5]

- (iv) The procedure, calculate, takes each item in turn from the stack. It alternately adds then subtracts the numbers until there are none left.

For example, if numStack contains:

2
6
5
12

It would perform  $2 + 6 - 5 + 12$  and output 15.

```

01   procedure calculate()
02       total = 0
03       add = true
04       if top == 0 then
05           print("Stack empty")
06       else
07           total = numStack[top - 1]
08           top = top - 1
09           while top != 0
10               if add == true then
11                   total = total + numStack[top - 1]
12                   add = false
13               else
14                   total = total - numStack[top - 1]
15                   add = true
16               endif
17               top = top - 1
18           endwhile
19           print(total)
20       endif
21   endprocedure

```

**5**

Complete the trace table for the procedure calculate. The current array and pointer values when the procedure is called are on the first line of the trace table.

top	numStack						total	add	Output
	0	1	2	3	4	5			
5	20	2	6	12	8				

**[6]**

- 2 A games company has developed a game called Kidz Arrowz. The players throw an arrow at a target board and are awarded different points depending on which circle the arrow lands. Fig. 1 shows the board.

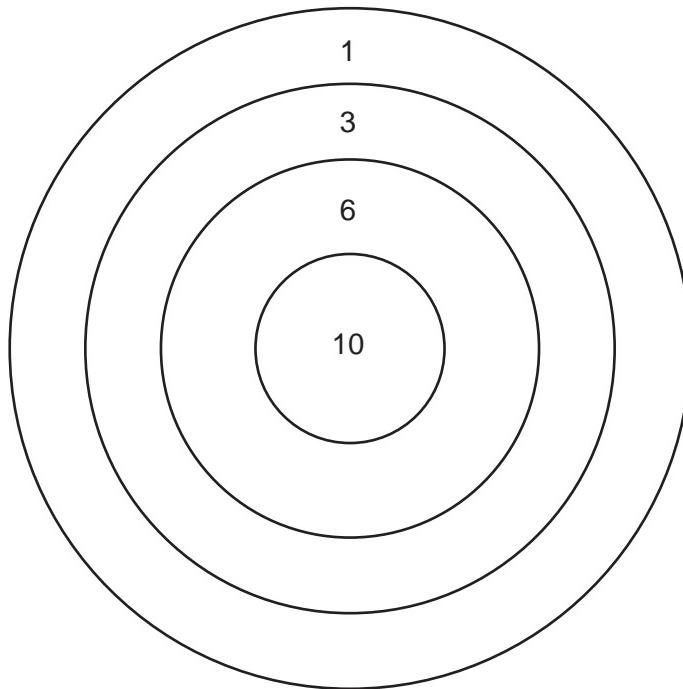


Fig. 1

A computer program is required to keep track of the scores for each competition. The user will enter the number of players, and the name of each player, in that competition to a maximum of 10. The program will then ask for the score of each player in turn. Each competition has 8 rounds, with each player throwing one arrow each round. The program will then display the total score of each player.

- (a) (i) The players are declared as a record structure:

```
record player(string playerName, integer totalScore)
```

Describe what is meant by a record structure.

.....  
.....  
.....  
.....

[2]

- (ii) The records for the players are stored in a 1D array.

State why a 1D array is a suitable data structure for the records.

..... [1]

- (iii) Three data structures are arrays, records and stacks.

Identify **one** other data structure.

..... [1]

- (b) The program is decomposed into multiple sub-programs, that each perform a specific task.

The array, `scores`, is declared as a global array of type record:

```
global array scores[10] of player
```

Explain why the array `scores` has been declared as global instead of local.

.....  
.....  
.....  
.....  
.....  
..... [2]

- (c) Player 1 is named Johnny. In the first round Johnny scores 3. Johnny can be added to the array using the code:

```
scores[0].playerName = "Johnny"  
scores[0].totalScore = 3
```

- (i) Write an algorithm to:

- allow the user to input and validate the number of players
  - allow the user to input the name of each player
  - output the round number at the start of a round
  - display the player number for the score that needs to be entered
  - allow the user to input the score for each player in that round and add it to their total.

. [7]

(ii) Write an algorithm to output:

- the total score of each player with their name e.g. Johnny scored 38
  - the average (mean) score of each player over the 8 rounds, with their name e.g. If Johnny's total score is 38, then Johnny's average is 4.75.

[4]

. [4]

**10**

- (d) (i) The programmer has decided to use a bubble sort to sort the players' scores in descending order of score.

Describe the disadvantages of using a bubble sort.

.....  
.....  
.....  
.....  
.....  
.....  
.....

**[2]**

- (ii) Despite the disadvantages, the programmer has decided to use a bubble sort for the players' scores.

Identify the characteristic of this problem that minimises the disadvantages of a bubble sort.

.....  
.....

**[1]**

11

- (iii) Write a procedure, sortScores, to perform a bubble sort on the global array scores to sort the players' scores into descending numeric order.

- [6]

**12**

- (iv) An alternative sorting method is the insertion sort.

A procedure, `insertionSort`, has been written to sort an array `numbers`. The procedure is incomplete.

Complete the procedure.

```
procedure insertionSort()
    for count = 0 to numbers.length - 1
        position = .....
        while position > 0 and numbers[position] < numbers[position-1]
            temp = .....
            numbers[position-1] = .....
            numbers[position] = temp
            position = .....
        endwhile
    next count
endprocedure
```

**[4]**

- (e) The programmer uses an Integrated Development Environment (IDE) to develop the program.

Describe how the IDE could be used to create the Kidz Arrowz program.

.....  
.....  
.....  
.....  
.....  
.....

**[3]**

13

- 3** A country's national rail operator wants to represent their rail network on a computer system to keep track of the location of trains, and any problems on the network.

After studying the rail network, the operator uses abstraction to create the virtual representation.

- (a) (i) Define the term 'abstraction'.

[1]

[1]

- (ii) Identify **two** reasons why abstraction is needed in the rail network program.

[View Details](#) | [Edit](#) | [Delete](#)

2 .....  
.....

[21]

[2]

- (iii) Describe **one** potential difference between the virtual and real rail network.

[2]

[2]

- (b)** The rail operator provides an app for customers to purchase tickets. An array is used to store the names of the stations on the network. Customers must enter a departure station into the app.

The current contents of the array are shown:

Cavalry Bridge Walkway Museum Monument Council House Theatre Cinema

A linear search is used to check if the entered departure station exists in the array.

- (i) Identify **one** precondition that is needed before a binary search could be used with the station array.

[1]

11

14

- (ii) A user enters the departure station “Bridge Heights”.

Explain how a linear search would check if the departure station exists in the array.

[4]

. [4]

- 4\*** A software company is developing a mobile phone application for a client which will allow customers to book cinema tickets, and is deciding between using the waterfall lifecycle or rapid application development.

Discuss the two software development methodologies the software company is considering and recommend which it should use. [9]

**END OF QUESTION PAPER**

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